BOOK REVIEWS.

SEND ALL COMMUNICATIONS TO W. H. BUSSEY, University of Minnesota.

Theory of Errors and Least Squares. By LEROY D. WELD. New York: The Macmillan Company, 1916. 12mo, pp. xii + 190, with eleven figures in the text. $1.25 (weight 18 oz.).

This very useful and handy little text-book embodies the material used by the author as lecture notes during twelve years. It presents the theory of errors and least squares in such a simple and concise form as to be suitable as a text-book for a brief undergraduate course, or as a convenient reference which any research worker with a little preparation in mathematics can read in a few hours and put into immediate practice.

Though certain more or less standard developments in the method of least squares are omitted, such as Chauvenet's criterion and the elegant method by Gauss of successive substitutions for the solution of normal equations, with its useful system of notation and checks, the author covers quite adequately the essentials of the subject. In the eight chapters he discusses in order: measurement, errors, probabilities, the error equation and the principle of least squares, the adjustment of indirect observations, empirical formulas, weighted observations, and precision.

Of the 190 pages in the book about forty-five are given over to exercises; perhaps twenty more pages are devoted to well-chosen illustrations of the applications of the developments discussed; and fourteen pages are used for an appendix containing, in addition to a few of the more complicated mathematical discussions, a collection of definitions, theorems, rules and formulas for convenient reference. Only through experience could one judge whether such an extensive complement of auxiliary matter is desirable in a text and reference book in which brevity seems to have been a prominent object. However, a glance at the illustrative examples and problems will show that they are drawn from various branches of science to suggest a wide range of useful application and in a small measure to exemplify the variety of ways in which ideas relating to the theory of errors and the method of least squares adapt themselves to the daily needs of the scientist in many fields of investigation. Much of the appendix also is designed to provide a convenient means of reference for the scientist who desires to apply least squares.

Although it may cause the scientist no serious inconvenience to find non-uniformity of notation in different textbooks of least squares in reference to standard quantities such as residuals, weights and probable errors, it would be an advantage if such notation could be standardized universally enough for use in headings and margins of tabulations where brevity combined with general intelligibility is demanded. Whereas Professor Weld employs the symbols ϵ and w to denote the much used quantities, probable error and weight, in eight well known textbooks which I find at hand discussing least squares in English

these quantities are designated by r and p respectively. Probably the chance of interesting investigators in the use of the method of least squares would be increased if confusion due to non-uniformity of notation could be avoided.

Every intelligent observer desires some concrete expression of the quality of his observations; the computer who has to combine the results of different series of observations should have some knowledge of their relative accuracy in order to assign to each series its proper weight; and the investigator engaged in a complicated series of experiments desires some criterion by which to estimate the relative errors of the several parts of his work and to apportion properly his care among them. Experienced judgment will go a great way, but the working method of least squares, which has been developed on the basis of experience and analysis into its present form by a succession of thinkers, presents clearly the safest means of obtaining the result of highest probability from a given set of observations and provides methods for appraising the accuracy of such a result and for expressing this accuracy vividly to others. The present volume is planned with the purpose of making the elements of the theory of errors and least squares easily attainable both by students and by research workers. It will prove useful in the class room, in reference libraries and also on the desk.

R. H. CURTISS.

Plane Trigonometry, with Tables. By A. M. HARDING and J. S. TURNER. G. P. Putnam's Sons, New York, 1915. 158 + 51 pages. $1.10 net.

It would be decidedly interesting to know how many trigonometries have been written since Nasir Eddin (or whoever it was) delivered the subject from its bondage to astronomy. It would be much more interesting to know how many authors have, more or less unconsciously, recast the material in the mould of an older form.

At present, in the writing of American trigonometries, we seem to be passing through a period which may, with some appropriateness, be called a "reversion to type." The trigonometry under review, like the Kenyon and Ingold (published 1913) and the Wilczynski and Slaught (published 1914), makes the discussion and solution of triangles the first consideration and admits no diversion until this problem has been completely solved. In the preface we find:

"During the last few years great modifications have been made in the method of presenting plane trigonometry. Formerly the student was introduced to the trigonometric functions without any explanation of their practical utility, and spent three-fourths of his time groping in the dark with trigonometric formulas and identities. The result was that the average student found the subject repulsive.

"In accordance with the modern tendency we have introduced the ratios a few at a time, and then proceeded as soon as possible to the solution of triangles, leaving the more difficult theoretical parts of the subject until the last."

And yet the Davies' *Legendre*, almost universally used in this country for a considerable period more than fifty years ago, made the solution of triangles